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NOTES ON GEOGRAPHIC DISTRIBUTON

Cuphea carthagenensis (Jacquin) J.F. Macbride, Lythraceae: a newly naturalised species from eastern Nepal

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Abstract. *Cuphea carthagenensis* (Jacquin) J.F. Macbride, a native of South America, is recorded for the first time from Mechinagar municipality of south-eastern Nepal. This weed has already been in the neighboring north-east region of India since the 1950s and might have recently spread into south-eastern Nepal where it is colonizing riparian habitats. We provide a detailed taxonomic account, as well as the distribution, major habitat, and invasion status of *C. carthagenensis*.

Key words. Alien species, *Brachyandra*, distribution expansion, first report, invasive species, riparian vegetation, weed species

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INTRODUCTION

With approximately 250–260 species, *Cuphea* P. Browne is the largest genus of the family Lythraceae. Most *Cuphea* species are primarily native to tropical and subtropical regions of the Americas (Graham 1968, 2017; Graham et al. 2006; Graham and Graham 2014; Facco et al. 2022). Brazil has the greatest diversity of *Cuphea* species with a total of 109 species, including 70 endemic species, distributed in all biomes (Cavalcanti et al. 2023). *Cuphea procumbens* Ortega, *C. ignea* A. DC., and *C. hyssopifolia* Kunth have been documented in Nepal (Shrestha et al. 2022), of which *C. procumbens* is a naturalized species (Hara and Williams 1979).

The diagnostic features of *Cuphea* are the presence of zygomorphic flowers with spurred, ribbed floral tubes, an enlarged dorsal nectariferous, globular to strap-shaped organ known as the "disc" at the base of ovary, and a unique seed dispersal mechanism. Unlike other members of Lythraceae, *Cuphea* seeds are exposed on a placenta during dispersal, which are exserted through coinciding longitudinal slits in the dorsal side of capsule and floral tube (Graham 1998, 2007, 2017; Graham et al. 2006). The genus *Cuphea* is divided into two subgenera, namely *C.* subg. *Cuphea* (previously, *C.* subg. *Lythrocuphea* Koehne) and *C.* subg. *Bracteolatae* S. A. Graham, and thirteen sections (Koehne 1874; Graham 1988, 2017; Graham et al. 2006). *Cuphea carthagenensis* (Jacquin) J.F. Macbride belongs to the section *Brachyandra* Koehne in *C.* subg. *Bractolatae*.

Cuphea carthagenensis is the most widespread species of the genus and frequently grows in open, mesophytic habitats such as in marshes, along trails and roads, in sunny ditches, and in pastures (Graham 1975, 2017; Bradley 2022; Facco et al. 2022). Several studies have confirmed its pervasive nature and documented it as a dominant weed species in agricultural landscapes, frequently disturbed sites, and waste lands, as well as the natural environments (Roath et al. 1993; Randhawa et al. 2006; Kosaka et al. 2010; Solfiyeni et al. 2013; Bradley 2022). *Cuphea carthagenensis* is native to South America; however, it is currently found in Central and North America, Australia, Pacific islands, the Caribbean, and Asia (Bradley 2022; Plants of the World Online 2023). In Asia, *C. carthagenensis* has been reported in Bangladesh, Borneo, China, India, Japan, Java, the Lesser Sunda islands, Myanmar, New Guinea, Peninsular Malaysia, Philippines, Singapore, Sulawesi, Sumatra, and Taiwan (Bradley 2022; European and Mediterranean Plant Protection Organization 2023; Global Biodiversity Information Facility 2023; Plants of the World Online 2023). We report the presence of *C. carthagenensis* for the first time from Nepal.

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METHODS

Cuphea carthagenensis was first noticed during a casual visit to an agricultural field. After assessing this plant species' general features and realizing its potential novelty in the area, multiple visits were made from November 2021 to January 2023 to various regions of Nepal, including the municipality of Mechinagar in Jhapa district (Figure 1). The main aims of these field visits were to assess the invasion status, extent of occurrence (**EOO**), morphological characters, phenology, and impacts of *C. carthagenensis* on native vegetation. Although commonly practiced in conservation biological studies, characterizing the EOO of an alien (and potentially invasive) species is still a novel concept (Shrestha et al. 2021; Rodríguez-Casal and Saavedra-Nieves 2022). For assessing the EOO, coordinates of the areas infested by *C. carthagenensis* were recorded using a GPS receiver. GeoCAT (Geospatial Conservation Assessment Tool; http://geocat.kew.org/), a browser-based tool that performs rapid geospatial analysis, was used to calculate EOO (Bachman et al. 2011; Rodríguez-Casal and Saavedra-Nieves 2022). Vegetative (height and number of branches) and reproductive characters (flowering or fruiting patterns, color of flower, and number of seeds), habitat characteristics, and associated plant species were recorded at the field site. Other taxonomic characters (trichome structure, microscopic floral features, and dimension of flower parts) were documented from studying collected specimens in the laboratory by using a STMPRO-T stereomicroscope (BEL Engineering, Italy). We identified the collected specimens by comparing them to the available literature (Koehne 1903; Graham 1998, 2007, 2017) and herbarium specimens deposited at the Royal Botanic Gardens Edinburgh Herbarium (**E**) and the online database of National Herbarium and Plant Laboratories (**KATH**). Specimens collected during field visits were pressed and dried following the standard procedures (Bridson and Forman 1998) and deposited at the KATH, Kathmandu, Nepal. We mapped the global distribution of *C. carthagenensis* based on occurrence data available in the Global Biodiversity Information Facility (GBIF, https://www.gbif.org/).

RESULTS

***Cuphea carthagenensis* (Jacq.) J.F.Macbr.**
Publ. Field Mus. Nat. Hist., Bot. Ser. 8: 124 (Macbride 1930)
Basionym: *Lythrum carthagenense* Jacq., Enum. Syst. Pl. 22 (Jacquin 1760)
Figure 2

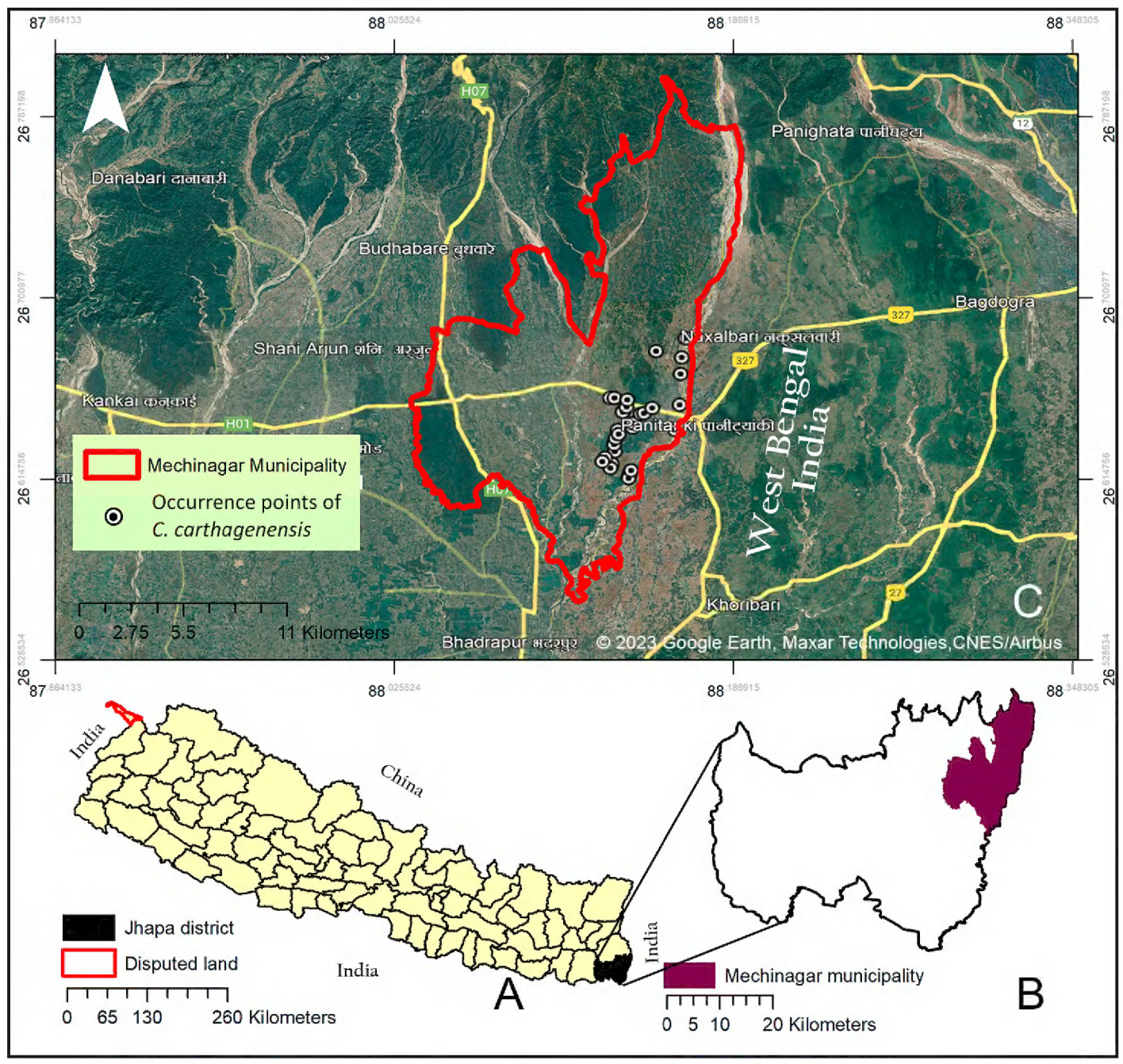

Figure 1. Maps showing the occurrence of *Cuphea carthagenensis*. **A.** Nepal. **B.** Jhapa district. **C.** municipality of Mechinagar with occurrence points. Data available at GBIF (https://doi.org/10.15468/gq5fb4).

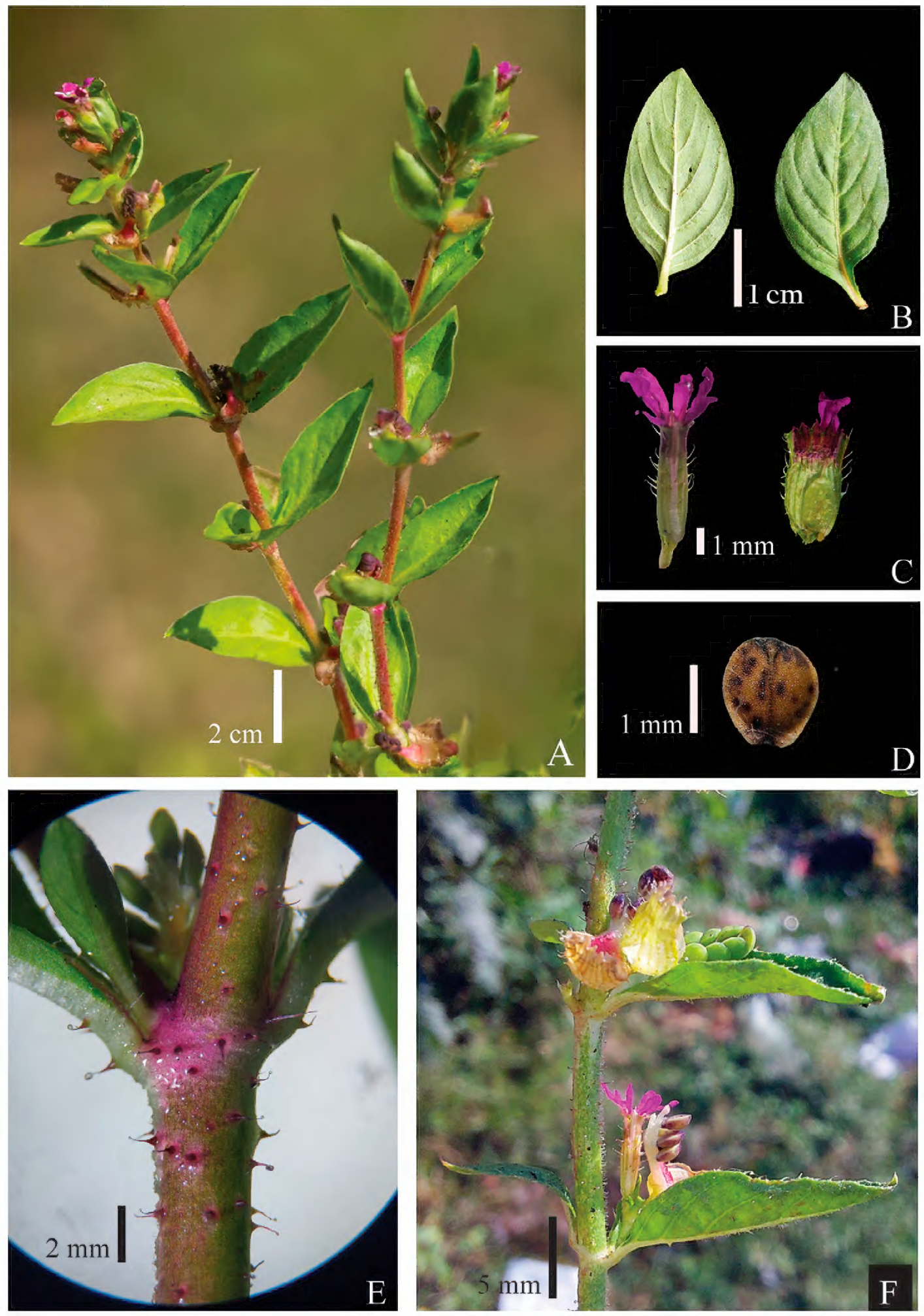

Figure 2. *Cuphea carthagenensis*. **A.** Branch. **B.** Leaf, Abaxial and adaxial view. **C.** Flower, intact and cut open. **D.** Seed. **E.** Nodal region with many glandular trichomes. **F.** Seeds exposed on the placenta and a flower from the axil of a leaf.

English name. Colombian Waxweed, Colombian Cuphea, Tarweed

Specimens examined. NEPAL – **Koshi** • Jhapa district, Mechinagar municipality, Ward number-7, Kalikhola; 26.6458, 088.1431; 137 m alt.; 12.X.2022; A. Neupane leg.; 2 spec., KATH AN22EN01 • Jhapa district, Mechinagar municipality, Ward number-7, Itabhatta; 26.6531, 088.1306; 141 m alt.; 11.VI.2023; A. Neupane leg.; 2 spec., KATH AN23EN01 • Jhapa district, Mechinagar municipality, Ward number-7, Ekata tole; 26.6536, 088.1287; 138 m alt.; 11.VI.2023; A. Neupane leg.; 2 spec., KATH AN23EN02.

Identification. Terrestrial, herbs to subshrubs, 30–60 cm (rarely to 90 cm) tall. Stems erect to sprawling, with many branches (up to 17 branches); surface viscid-pilose, trichomes both glandular and non-glandular; glandular trichome long; non-glandular short and curved; leaves opposite, gradually reduced in size towards terminal region; petioles to 4.5 mm long; blades elliptical, rarely ovate, 12–55 × 6–22 mm, with base attenuate, acute apex, margin entire, minutely scabrous on both surface and margins. Flowers axillary, minute, interpetiolar, solitary, bracteoles 2, pedicel 1.2–1.5 mm long; floral tube 4–7 mm long, spurred, 12-veined, veins bear trichomes, intercostal areas usually glabrous, inner surface glabrous and also pilose near stamens; calyx 6-lobed, sinuses of sepals unequal; small lobes of epicalyx present at sinuses of sepals, glabrous or with a single seta. Petals 6, rose-purple to purple or rarely white, to 2.5 mm long,

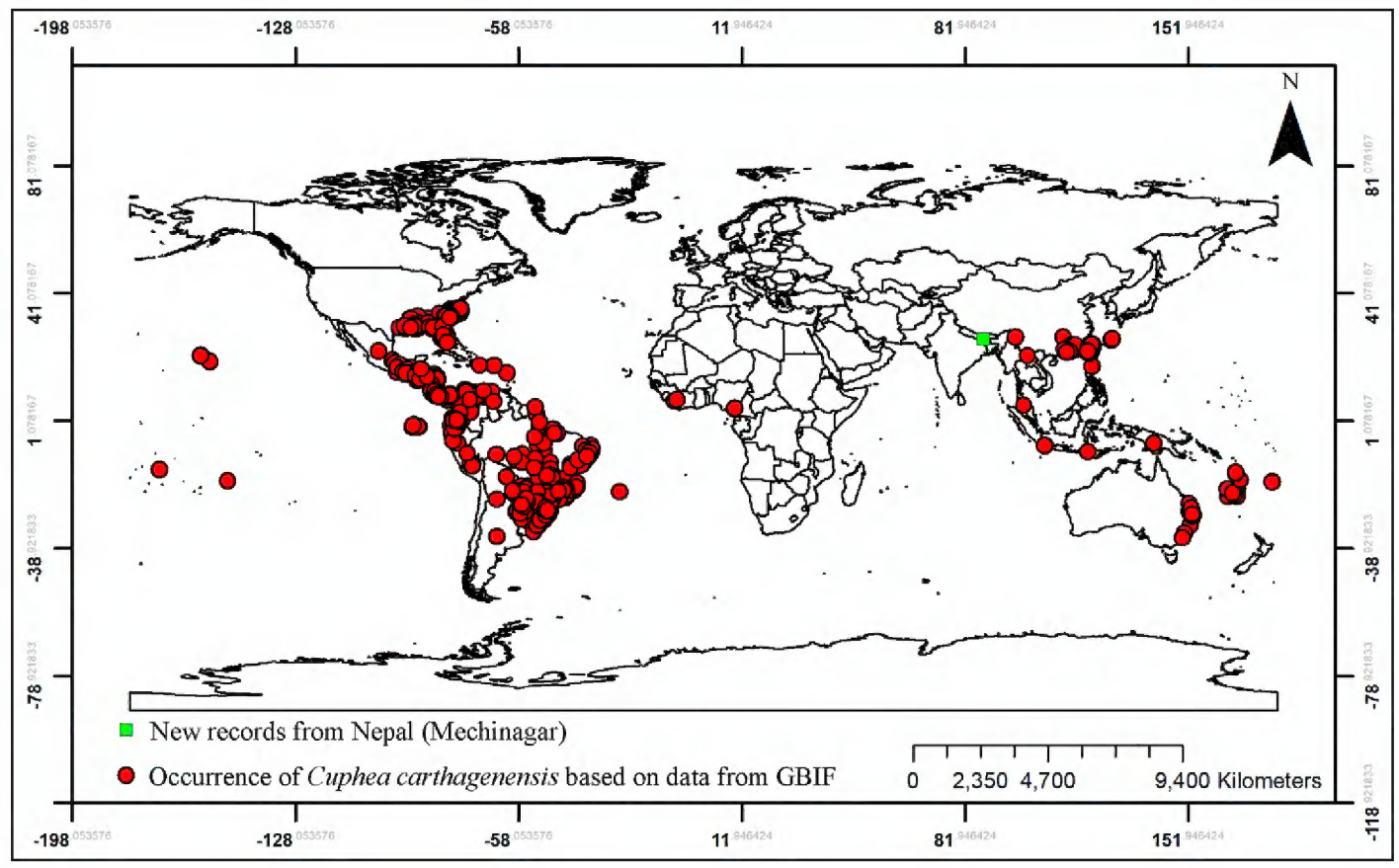

Figure 3. Global distribution of *Cuphea carthagenensis* based on occurrence data available in GBIF (https://gbif/10.15468/dl.umng7f).

oblong or subspatulate. Stamens 11, unequal, inserted; filaments whitish and glabrous; anther pale, with purple tint. Ovary glabrous; style glabrous; ovules 6–9. Seeds 1.4–1.8 mm long, brown, obovate to subcircular, with thin margin (Figure 2).

Flowering and Fruiting. Flowering from May to December and fruiting from June to January.

Distribution. *Cuphea carthagenensis* is global in distribution, from South and North America to East Asian countries, eastern Australia, and a few countries of Africa (Figure 3). In Nepal, it is currently known to occur only in the municipality of Mechinagar, Jhapa district, in south-eastern Nepal (Figure 1). At present, this species is known to grow along the banks of the three main rivers in Nepal, the Mechi, Kali, and Palia, and connected irrigation canals and streams in the municipality of Mechinagar. It is not so common in areas farther from water bodies. We found this weed growing mostly along sandy riverbanks, in marshy areas, along the sides of irrigation canals and drainages, and in damp agricultural lands and tea estates (Figure 4). At most of the sites, *C. carthagenensis* formed relatively low cover with apparently no harm to surrounding native vegetation. However, at a few locations, plants were aggressively growing and forming dense monoculture stands which displaced native species. Commonly associated species of *C. carthagenensis* were *Alternanthera philoxeroides* (Mart.) Griseb., *Alternanthera sessilis* (L.) DC., *Cyperus* spp., *Enydra fluctuans* Lour., *Fimbristylis* spp., *Floscopa scandens* Lour., *Ipomoea* spp., *Ludwigia* spp., *Persicaria* spp., *Pontederia crassipes* Mart., *Rotala rotundifolia* (Buch.-Ham. ex Roxb.) Koehne, and *Scoparia dulcis* L.

DISCUSSION

Cuphea carthagenensis has already been reported in the North-East and the neighboring West Bengal regions of India (Paul and Kumar 2016; Bradley 2022; Plants of the World Online 2023). Its occurrence in the India and spread along the banks of the Mechi river suggest that *C. carthagenensis* may have crossed the international border by way of various passive dispersal pathways, such as by wind, water, or birds and other animals (Kosaka et al. 2010). Interconnected rivers and irrigation canals may have facilitated this dispersal. Based on the EOO of 22 km^2 and our field observations, this weed is likely to be in its establishment stage in Nepal (Blackburn et al. 2011). Most of the local people do not recognize this weed, and those who identified it in their locality believe that it has been present for over 5 years and has been invading waterways and agricultural land (personal communication with local people on 2023/05/13 by A. Neupane). However, *C. carthagenensis* has the potential to spread and become invasive due to characteristics that it has in common with other invasive species, such as high resistance and adaptability to newly disturbed habitats, faster growth rate, and high reproductive potential (Throne 1951; Graham 1975; Naithani and Bennet 1990; Roath et al. 1993; Randhawa et al. 2006; Kosaka et al. 2010; Xu et al. 2012; Solfiyeni et al. 2013; Paul and Kumar 2016; Bradley 2022). Lastly, this species has the potential to be a threat to the natural ecosystem, so it is necessary to monitor its status regularly and prevent it from spreading further.

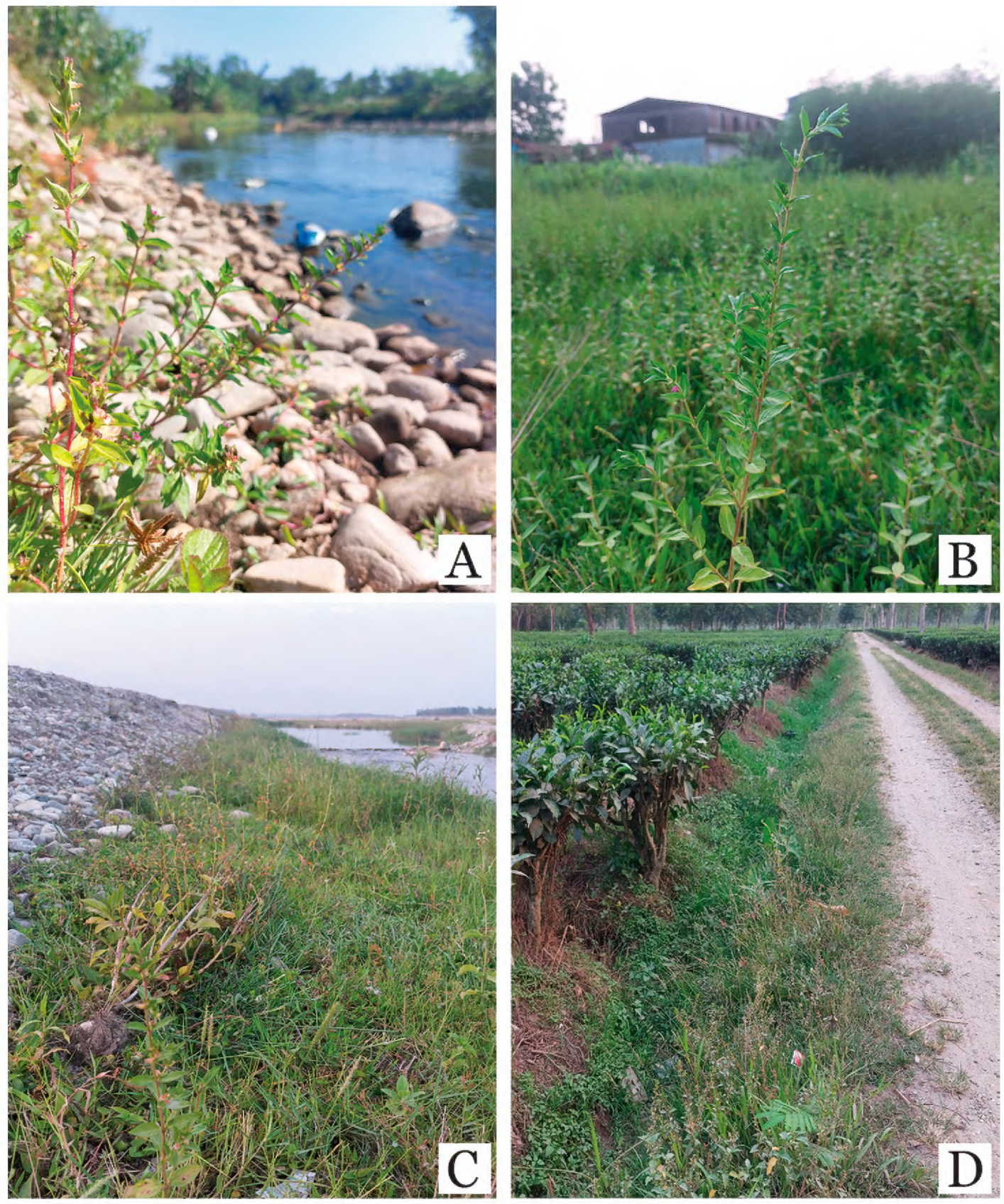

Figure 4. Habitats of *Cuphea carthagenensis*. **A.** Riverside. **B.** Agricultural land. **C.** Irrigation canal. **D.** Tea estate.

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ADDITIONAL INFORMATION

Conflict of interest

The authors declare that no competing interests exist.

Ethical statement

The authors declare that there are no ethical issues and no ethical statement.

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Author contributions

Conceptualization: AN, BA, BBS. Data curation: AN, BA, BBS. Formal analysis: AN. Investigation: AN. Methodology: AN, BA, BBS. Resources: AN, BA. Supervision: BA, BBS. Validation: AN, BA, BBS. Writing – original draft: AN. Writing – review and editing: AN, BA, BBS.

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Data availability
Geographic coordinates of *Cuphea carthagenensis* in the municipality of Mechinagar are available at GBIF (https://doi.org/10.15468/gq5fb4).

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